PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

PLANTERS' BULLETIN FORTY-FOUR

CONTENTS

	Page
Editorial: Weedkillers	99
Control of Weeds on Malayan Rubber Estates	100
Transplanting Stumped Buddings	116
SP Rubbers in the First Half of 1959	120
Approved Fungicides for Mouldy Rot Control	121
RRI News, Correspondence, Note	122, 123

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R R I

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PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur September 1959 Number 44

Editorial: Weedkillers

The large scale use of weedkillers on rubber plantations is a post-war development. Though the methods of employing sodium arsenite and sodium chlorate had long been established, these two chemicals were first extensively used in the reclamation of neglected areas at the end of the war, when the shortage of labour and its relatively high cost made older methods of hand-weeding uneconomic. Since then there has been general recognition of the economic advantages of employing weedkillers for the control of vegetation competing with young rubber. On estates which have not suffered from neglect, the routine control of weeds along the planting rows is likely to remain the most important task in which herbicides can profitably be employed.

The modern technique of poisoning weeds has a special value for tropical agriculture in that soil cultivations along the planting rows, which have now been superseded by spraying, were liable to result in rapid oxidation of soil organic matter, loss of soil structure and erosion. On the other hand weeds which are killed, but not removed, give protection to the soil, improve structure and facilitate the incorporation of fertilisers.

Although the advantages of using herbicides for routine weed-control are generally admitted, the choice of a suitable chemical often raises practical problems: one of the most difficult decisions to make is whether to use sodium arsenite or to replace it by a substance less dangerous to humans and animals.

The principal article of this issue makes clear the important part now played by sodium arsenite in the routine control of weeds on plantations. The preference for sodium arsenite has arisen from its general effectiveness against a wide range of weeds and its relatively low cost. The Malayan Trade Returns for 1958 demonstrate the leading position of sodium arsenite amongst weedkillers. More than 6,420 tons of the chemical valued at over four and a quarter million dollars were imported, compared with less than one and a half million dollars' worth of all other weedkillers.

Some restriction on the use of sodium arsenite has been imposed by the Poisons (Sodium Arsenite) Ordinance of 1949, since inability to conform with the requirements of the ordinance makes it necessary for some growers to use alternative weedkillers. The existence of legislation on the use of sodium arsenite indicates the nature of the risks involved. Legislation cannot however prevent all accidents; not only

humans and animals but also rubber trees are susceptible to arsenite poisoning, as is shown by the recorded instances of tree deaths which have been traced to unskilful use of this weedkiller.

The rubber industry and legislators alike seek effective, economical substitutes for sodium arsenite. The materials which we have received for examination come from countries whose principal economic crops are "grasses" and, as a result, we have only a limited number of promising weedkillers for use in rubber plantations — where grasses are generally the most important weeds. Nevertheless, there have been encouraging successes in recent years with some new chemicals, of which dalapon has been the most notable example. A careful watch is maintained at the Rubber Research Institute to ensure that no herbicide, potentially useful in rubber cultivation, is overlooked.

Control of Weeds on Malayan Rubber Estates

CONTROL OF WEEDS BY SPRAYING WITH CHEMICALS is now a regular feature of work on rubber plantations. Since 1953, when the use of weedkillers on rubber estates was reviewed in *Planters' Bulletin 4*, new developments in weedkilling practice have been reported from time to time. The aim of this article is to summarise the developments of the last six years and to give the planter an up-to-date account of the uses of weedkillers available in Malaya and of their application to particular weeds. For rapid reference a table summarising the properties of the various chemical weedkillers is included on page 115.

THE MAIN PROPERTIES OF AVAILABLE WEEDKILLERS

Sodium Arsenite

This is a non-selective contact herbicide which is currently used mainly for routine control of grasses and other small herbaceous plants along planting rows. In the past it has been used also for eradication of lalang and bracken, and for control of all types of weeds including woody species such as Straits rhododendron (*Malastoma polyanthum*). Despite its poisonous* nature, it is still favoured by rubber growers for routine weed control work because it is the cheapest and most effective

* There are strict regulations in force governing the purchase and use of sodium arsenite for agricultural purposes, including records to be kept by estate managers. A permit to purchase must be obtained from the Head of the Medical Department of the State concerned. The Regulations cited as the *Poisons (Sodium Arsenite) Regulations 1949* are published as *L.N. 92* in *Legislative Supplement to Federation of Malaya Government Gazette No. 13 Vol. 11*, dated 7 March 1949, with amendment *L.N. 622* in *Legislative Supplement to Gazette No. 56 Vol. 11*, dated 24 December 1949.

general herbicide available. A 1½% solution (15 lb sodium arsenite in 100 gallons of water) is commonly used.

The highly poisonous nature of sodium arsenite cannot be too strongly emphasised. It is dangerous to human beings and to animals, and if it comes in contact with the bare skin it may cause an unpleasant dermatitis. In Malaya the sale and distribution of sodium arsenite is controlled by special regulations in which emphasis is laid on the use of easily-identified containers sufficiently strong to prevent leakage. During storage and transport, sodium arsenite must be completely separated from any foodstuffs. Full precautions are required for the protection of labourers: regulations cover medical attention, use of protective aprons, and washing of cloths and hands before eating.

No spraying with arsenic is permitted in any area where there is risk of contaminating water supplies used for human consumption. Warning notices in the appropriate language have to be displayed where spraying has been done in cattle grazing areas.

Sodium Chlorate

In the concentrations normally used for spraying weeds this acts as a non-selective contact herbicide. It is a substitute for sodium arsenite in the routine control of grasses and other small herbaceous growths along planting rows, although less effective as a general weedkiller. Experience has shown that a 2½% solution is about the minimum effective concentration. It is readily soluble in water and is non-toxic to humans and animals. It can thus be safely used as an alternative to sodium arsenite in water-catchment areas and in other areas where the use of sodium arsenite is not permitted.

Sodium chlorate is readily leached from soils and in the concentrations normally applied it has little or no effect in preventing germination of weed seeds in top soil. No harmful effect on the soil or crop following repeated applications is likely to occur.

When spraying weeds in tree rows, care should be taken to avoid contact of sodium chlorate solution with the stems of young rubber plants but the risk of damaging the rubber plants is much less than with sodium arsenite.

Sodium chlorate should be handled with care and stored in closed metal containers. When dry, it is easily ignited by friction and may be explosive in contact with weeds, dried vegetation, cloth and other organic materials. It thus constitutes a fire hazard but under Malayan conditions the risk of fire in sprayed areas is very small. Labourers should be warned of the danger of standing near a fire or drying clothes wetted by chlorate solution. Their clothes should not be allowed to dry until the chemical has been washed out.

Oils

These are useful non-selective contact herbicides and have been widely used locally, mainly for control of grasses including lalang

(*Imperata cylindrica*). A variety of oil products are offered by local commercial firms. These are Diesel Oil, Shell Lalang Oil WX, Shell Lalang Oil A-601, Sovacide PY and Sovacide PYD. Oils with a high content of aromatic hydrocarbons, such as Shell Lalang Oil A-601 and Sovacide PY, are claimed to be more effective than the others but there appears to be little experimental evidence to support this belief which is based on observations that the grasses turn brown rather more quickly when the oils with a high aromatic content are used.

As with sodium arsenite and sodium chlorate, several rounds of spraying with oils have to be carried out for complete elimination of lalang or other grasses. Because they are relatively more costly, oils are now seldom used for spraying. Their use is restricted mainly to control of sporadic growth of lalang by wiping. The procedure normally followed for eradication of heavy growth of lalang is to use solutions of sodium arsenite or dalapon for spraying, and after this to wipe sporadic re-growth with oil.

Sodium Salt of Trichloroacetic Acid (T.C.A.)

Often referred to in the literature as 'TCA' and available locally under the trade name Lallicide, this is a white crystalline powder readily soluble in water. It is classified as a translocated herbicide as it is absorbed mainly through the roots and translocated within the plant. It is primarily a grass-killer and cannot be recommended as a general weedkiller. Few broad-leaved weeds can be successfully eradicated except by treatment at the seedling stage, although with heavy rates of application it will kill many bushy growths and may cause severe damage to tree crops. It can be used for control of grasses in rubber areas without serious risk of damaging the rubber, provided that the rate of application does not exceed 30 lb per acre. For control of lalang, applications at the rate of 100 lb per acre or more are required but the smaller grasses such as *Axonopus compressus* and *Paspalum conjugatum* can be effectively controlled by spraying with a solution of 20 to 25 lb of sodium trichloroacetate in 100 gallons of water. Because of the relatively large amounts required and the consequent high cost, Lallicide is not widely used for weed control in rubber areas.

Lallicide has an advantage in that it is non-toxic to humans and animals, but precautions are necessary when handling it, as it has an irritant effect on the skin.

Dalapon

This is the sodium salt of 2,2-dichloropropionic acid and is available locally under the trade names Dowpon and Basfapon. It is a translocated herbicide and is actively absorbed both by the foliage and by entry from the soil into the roots. Therefore the risk of failure due to rain falling soon after spraying is much less than with some other weedkillers, e.g. sodium arsenite, which act only as contact herbicides and are absorbed only by the foliage.

Dalapon is recommended for control of lalang by spraying and for control of most of the smaller grasses commonly found in rubber areas but it is ineffective against *Paspalum conjugatum*. It enters mainly through the leaf but to a less extent through the soil and root system. Effects are slow in developing and the maximum effect may not be observed until about 6 weeks after spraying. The minimum effective dose for control of the smaller grasses such as *Axonopus compressus* is 8 to 10 lb per acre, depending on density of growth.

Dalapon may safely be used for weed control in rubber areas without risk of injury to the trees, provided the rate of application does not exceed 15 lb per acre. With higher rates of application, defoliation and dieback of the rubber plants may occur, although the damage is unlikely to be serious with applications in the range 15 to 25 lb per acre. Some clones are more susceptible to these phytotoxic effects than others.

For rubber nurseries the rate of application should not exceed 10 lb per acre. Care should be taken to avoid contact of the solution with the leaves of rubber plants but accidental contact with the brown stem is not likely to cause any ill effects. No precautions are necessary to protect the stems of rubber trees when spraying along tree rows (strip spraying).

Dalapon persists in the soil for varying periods, depending on the concentration and on weather conditions, and may damage crops sown within a few weeks after spraying. It nevertheless decomposes fairly rapidly in warm, moist soil as a result of soil microbial activity. It is probably safe to sow ground covers (legume creepers) about one month after spraying with dalapon at the rate of 10 to 15 lb per acre.

Dalapon is a very safe chemical to use. It is readily soluble in water and without any serious handling hazards. The powder can irritate the skin if it is allowed to remain in contact for prolonged periods and can cause irritation to the eyes, though serious injury is not likely to occur. The solution prepared for spraying is quite safe to handle and no special precautions are necessary.

Aminotriazole (ATA, Amizol)

This is a new herbicide which is not yet available locally in sufficient quantities for large scale use but can be imported if there is likely to be a demand for it. It is mentioned here because it can be considered as a possible alternative to dalapon for control of *Paspalum conjugatum* (which is resistant to dalapon) and sedges.

Aminotriazole is a white crystalline powder readily soluble in water. It can be absorbed through either root or shoot and is readily translocated throughout the plant. Its most striking effect is the production of chlorotic or albino shoots. This effect, and the recovery from it, varies depending on the plant species and on the dose applied. It is not a highly selective herbicide although some plants are more susceptible

to it than others. It cannot be regarded as a useful general weedkiller comparable with sodium arsenite.

No firm recommendations regarding the use of this new weedkiller can be made yet except for control of *Paspalum conjugatum*. After further testing it may possibly find a place in the weed control programme on rubber estates. It is non-toxic to humans and animals.

Auxin-Type Growth Regulators (2,4-D and 2,4,5-T)

These are highly selective herbicides frequently referred to as 'hormone-weedkillers'. There is a large variety of these chemical compounds but the ones which are generally used in Malaya today are formulations of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T).

These 'hormone-weedkillers' have no effect on grasses but will kill most non-gramineous plants when employed at suitable concentrations. They are absorbed by both roots and shoots and are readily translocated throughout the plants. They are highly active chemicals and there is considerable danger of spray 'drift' damaging young rubber plants when spraying broad-leafed species of weeds in rubber areas. To avoid this possibility, spraying should be done on days when there is little or no wind. These weedkillers are non-poisonous to man and animals.

2,4-D — Several forms of 2,4-D are available but the one most commonly used locally is the sodium salt of 2,4-D sold here under the trade name Fernoxone. It is a white, free-flowing powder readily soluble in water. Suitable solutions for spraying can be prepared by dissolving 1 to 5 lb Fernoxone in 100 gallons of water, the concentration depending on the type of weed to be eradicated. It can be used for control of many soft, broad-leafed weeds, including *Mikania scandens* and many small herbaceous growths, Siam weed (*Eupatorium odoratum*), wild banana, and some aquatic weeds such as water hyacinth (*Eichhornia crassipes*). It is not a very effective killer of the more woody types of growth.

2,4,5-T — The form in which this is generally used as a weedkiller is the butyl ester 2,4,5-T, available locally under the trade name Trifen. It is a dark-brown, viscous liquid insoluble in water but soluble in diesel fuel oil. A solution suitable for spraying can be prepared by dissolving 2 pints of the butyl ester of 2,4,5-T in 25 gallons of diesel oil, or 1 gallon in 100 gallons.

The butyl ester of 2,4,5-T is generally more effective than Fernoxone and other forms of 2,4-D, particularly on woody plants, and it kills a larger variety of plants. Largely because of its high cost it is seldom used alone except as an arboricide for killing trees.

Mixture of 2,4-D and 2,4,5-T esters — For weedkilling purposes a commercial product containing a mixture of the esters of 2,4-D and 2,4,5-T is generally preferred — both for reasons of economy and because of the greater range of weed species controlled by including the

two chemicals. Such a mixture is available locally under the trade name Floroxone. This is a water-miscible preparation containing the esters of 2,4-D and 2,4,5-T in equal proportions. It is a dark coloured viscous liquid and a solution suitable for spraying weeds can be prepared by thoroughly mixing ½ to 4 pints of Floroxone with 100 gallons of water, the concentration depending on the types of weeds to be eradicated.

Floroxone is a general purpose type of hormone weedkiller recommended for eradication of broad-leafed species of weeds that are resistant to the cheaper Fernoxone. As a general guide it can be accepted that Floroxone is likely to give better results than Fernoxone on woody plants (e.g. Straits rhododendron) and on bracken, mimosa and self-sown rubber seedlings.

Like Fernoxone and all other hormone weedkillers, Floroxone is non-poisonous to man and animals when used in the concentrations normally used for spraying weeds.

PREPARATION AND APPLICATION OF SPRAYS

Wetting Agents

When preparing aqueous solutions of the chemicals mentioned above for spraying weeds it is recommended that a spreading or wetting agent should be added to the solution to ensure that the leaves are thoroughly wetted. The following wetting agents are suitable and are available locally — Teepol, Lissapol N, Comprox A, Comprox AC and Comprox 2730. Any one of these may be used and should be added to the solutions prepared for spraying at the rate of about 4 fluid ounces in 100 gallons.

Precautions against Damage to Trees

Contact with leaves — When spraying weeds in planted areas care must be taken to avoid contact of the spray solution with the foliage of young rubber plants. The hormone type weedkillers in particular, such as Fernoxone and Floroxone, are so highly active that there is considerable danger of spray drift damaging young rubber trees. Accidental contact of the other weedkillers such as sodium arsenite, sodium chlorate and dalapon may cause severe scorching of the leaves but more permanent damage is unlikely.

Contact with stems — Care must be taken also to avoid contact of the spray solution with the stems of rubber plants. This applies in particular to solutions of sodium arsenite; even a few drops of this solution may cause severe wounding of the stems and it is advisable to use metal guards or sacking to protect the stems of young rubber plants when spraying weeds along planting rows. The risk of injury is much less with sodium chlorate and still less with dalapon. Protection of the stems of young rubber is not necessary when spraying with dalapon

and probably unnecessary also when using sodium chlorate, provided reasonable care is taken to avoid spraying the stem.

Contact with roots — The risk of damage due to absorption of the chemicals from the soil through the roots is very small, provided the rates of application recommended are not exceeded. Defoliation of the rubber, possibly followed by dieback, may occur if dalapon is applied at rates higher than 15 lb per acre. Some clones appear to be more sensitive than others to high rates of application of dalapon. Similar effects may be observed if Lallicide is applied at a higher rate than about 30 lb per acre. The risk of damage by sodium arsenite entering the soil is very small because the arsenic is rapidly fixed in an insoluble form by chemical combination with iron compounds: quantities much in excess of those normally used for control of weeds on rubber estates would be required to produce toxic conditions in the soil. No harmful effect on the soil is likely to occur following repeated applications of oils, sodium chlorate or the auxin type weedkillers.

CONTROL OF SPECIFIC WEEDS.
1. GRASSES AND SEDGES

Lalang (Imperata cylindrica)

If open lalang land is to be cleared for planting with rubber the cheapest method of eradicating heavy growth of lalang is by mechanical cultivation with tractor-drawn implements. A well-proven method is to go over the area first with a bulldozer to clear ant-hills, tree stumps and other impediments. After clearing, the area is ploughed, using a wheeled tractor with the plough mounted hydraulically. This is followed by harrowing and then by a second ploughing, preferably, if the physical features of the terrain permit, at right angles to the first. It is debatable whether a second round of harrowing after the second ploughing has any advantage. Routine control of sporadic regrowth of lalang, by the oil wiping procedure or by spot spraying, is done after the final ploughing, once every six weeks or two months.

An alternative method is to spray the lalang with chemical weedkillers. This is a method that is recommended for eradication of lalang in rubber areas both on estates and smallholdings, although it can also be used for clearing open lalang land for planting when mechanised equipment is unavailable or unsuited to local conditions.

For eradication of heavy growth of lalang by spraying, sodium arsenite has been widely used in the past but dalapon (Dowpon or Basfapon) is now recommended as a better alternative.

Dalapon has important advantages over sodium arsenite and the overall cost should not be appreciably higher. The main advantages of using dalapon are:

(i) it is non-poisonous to man and animals.

(ii) the risk of complete failure due to heavy rain falling soon after spraying is much less than when using sodium arsenite.

(iii) only a single round of spraying with dalapon is usually required before sporadic regrowth of lalang can be controlled by wiping with oil, whereas at least three, and sometimes four or five rounds of spraying with sodium arsenite would be required to produce a similar result.

(iv) no precautions are necessary to protect the stems of rubber plants when spraying lalang and other grasses in the tree rows.

The procedure recommended is to spray the lalang with a 1½% solution of dalapon (15 lb dalapon in 100 gallons of water) at the rate of 100 gallons per acre. A wetting agent such as Teepol, Lissapol N, Comprox A, Comprox AC or Comprox 2730 may be added to the solution at the rate of about 4 fluid ounces per 100 gallons. It is essential to apply sufficient solution to obtain a complete coverage — the volume applied per acre of ground covered with lalang should not be less than 100 gallons.

The effects of dalapon develop gradually after spraying and the maximum effect may not be observed until about six weeks after application. However, it should be possible to judge whether spraying has been effective after about three weeks and patches which remain green should be sprayed again with a similar solution. Sporadic regrowth may begin at about 10 to 12 weeks after spraying but most of the new shoots that appear first are single shoots growing from seed which can easily be uprooted by hand pulling. Small tufts of new growth will continue to appear and these should be eliminated by wiping with oil. Routine control of sporadic new growth by wiping with oil should continue at regular intervals, commencing at about three months after spraying with dalapon, until the lalang is completely eradicated.

Grasses Other Than Lalang

Apart from lalang, a large variety of smaller grasses may be found among the weed population in rubber areas. These are, indeed, the most persistent weeds and are mainly responsible for the frequently high cost of upkeep in rubber areas, particularly in young replantings. Common species are — *Axonopus compressus, Paspalum conjugatum, Panicum nodosum, Ischaemum muticum, Tricholaena rosea, Cyrtococcum accrescens* and several others which are less common but may assume dominance in localised areas.

Most grasses can be controlled by spraying with a solution of sodium arsenite but repeated spraying is necessary for their complete eradication. A procedure commonly followed is to spray the grasses (and other weeds) with a 1½% solution at 2-monthly intervals in the younger rubber areas. Later, as the overhead canopy begins to develop, the frequency is reduced to 3- and then to 4-monthly intervals. Finally, when

the shade provided by the crowns of the rubber trees is almost complete, spraying at 6-monthly, and sometimes 12-monthly intervals is adequate to keep grasses under control.

For maintaining clean weeded strips along planting rows, sodium arsenite has the advantage in that it is a non-selective weedkiller capable of controlling the growth of many other weeds besides grasses.

A 2½% solution of sodium chlorate is effective in killing grasses and most of the small herbaceous weeds; it is therefore a suitable and, furthermore a non-poisonous alternative to sodium arsenite for maintaining cleared strips along planting rows. The treatment of strips along planting rows is dealt with in a separate section, page 114.

Sodium chlorate is particularly effective in killing the grass *Ischaemum muticum* and for this specific purpose it is superior to sodium arsenite. Complete eradication of this grass species can be achieved with two rounds of spraying with a 2½% solution of sodium chlorate.

Dalapon is the most effective grass killer. It is particularly effective in killing *Axonopus compressus* and most of the other grasses commonly found in rubber areas, except *Paspalum conjugatum*. It can be thoroughly recommended for routine control of weeds in areas where grasses are the dominant weed species. Compared with sodium arsenite and sodium chlorate, the effect of dalapon develops more slowly. Rate of recovery of grasses, however, is much slower and growth of grasses in open ground or in young rubber areas can be effectively controlled by spraying at intervals of 5 or 6 months. Invasion by broad-leaved herbaceous growths, however, may occur in the intervals and it may be necessary to spray these weeds with sodium chlorate or 2,4-D. Under heavy shade of mature rubber trees, spraying once a year would probably be sufficient to eliminate grasses. A solution containing 8 to 10 lb (depending on density of growth) of dalapon in 100 gallons of water is recommended for the initial round of spraying but it is anticipated that weaker solutions could be used for subsequent rounds.

For routine control of weeds along planting rows, dalapon has the disadvantage that it is more selective than sodium arsenite and sodium chlorate; the possibility of using dalapon in combination with Fernoxone for this purpose is discussed in the section on 'Control of Weeds in Planting Rows'.

Amizol (aminotriazole) is a new weedkiller that has not been used on a large scale locally but it is mentioned here because it is particularly effective in killing *Paspalum conjugatum*, the one grass that has been found to be resistant to dalapon. It can therefore be used as a substitute for dalapon in areas where *Paspalum conjugatum* is the dominant grass species. It has little effect on *Axonopus compressus* but kills most of the other small grasses. A solution containing 10 lb of aminotriazole in 100 gallons of water is recommended for the initial

spraying of heavy growth of *Paspalum conjugatum* but weaker solutions may be used for subsequent rounds of spraying at intervals of about 5 or 6 months. The effect of aminotriazole persists much longer than that of sodium arsenite or sodium chlorate and therefore the number of spraying rounds required for routine control of *Paspalum conjugatum* in young rubber areas will be less. It is expected that two, or at the most three, rounds of spraying per annum will be sufficient on the more open areas and still fewer in shaded areas.

In small scale trials, applications of aminotriazole at rates up to 20 lb per acre have had no harmful effects on rubber. It has also been used in closely planted young rubber nurseries at rates up to 10 lb per acre without any noticeable ill effects.

It is desirable that planters should learn to identify some of the most common grasses and particularly to distinguish between *Axonopus compressus* and *Paspalum conjugatum* (See illustrations. *Axonopus compressus* is the most common and persistent grass in rubber areas, particularly under a full canopy. *Paspalum conjugatum* is more frequent in open areas and younger replantings). They can then decide whether dalapon or aminotriazole should be used for spraying in any particular area. The former should be used where *Axonopus compressus* is abundant while the latter can be expected to give better results in areas where *Paspalum conjugatum* is dominant. Mixtures of the two weedkillers would seem to be the obvious solution to the problem; such mixtures have been tried in small scale trials with varying success. Good results were obtained, in a three-year-old rubber area, with a mixture of 5 lb dalapon and 5 lb aminotriazole in 100 gallons of water per acre. A mixed population of weeds, including heavy growth of *Paspalum conjugatum* in patches, was effectively controlled with little or no recovery at 2 months after spraying. In this trial the mixture of dalapon and aminotriazole was appreciably more effective then sodium arsenite and is worth a trial on a larger scale.

Sedges

The sedge that is most commonly found locally is *Scleria multifoliata*, usually known locally under the name '*sendayan*'. This and other sedges are resistant to sodium arsenite and sodium chlorate, but they can be killed by spraying with solutions of either dalapon or aminotriazole.

In a small scale trial, heavy growth of *Scleria multifoliata* was killed by spraying with a 2% aqueous solution (20 lb in 100 gallons per acre) of either of the two weedkillers. One year after spraying, new growth amounted to not more than 10% of the original stand. Weaker solutions can be used for control of more sporadic growth and it has been noted that the odd tuft of sedge growing in a mixed population of grassy weeds is killed when dalapon is applied at the rate of 10 lb in 100 gallons of water per acre.

Axonopus compressus

A. Dense tufts joined by short stolons; roots white to yellow; nodes pale, hairs on nodes up to 0.1 inch long; inflorescence usually more than two spikes.

B. Junction of leaf sheath and blade marked by fine membranous ligule edged with fine hairs, adjacent base of blade usually pale; leaf blade often crinkled, broadest in the middle, edges parallel for half length of blade.

C. Spikelets elliptical, set alternately on either side of spike; those on one side do not overlap.

Flowering specimens of Axonopus compressus *and* Paspalum conjugatum *are easily distinguished. Non-flowering specimens are similar in many respects: as both species vary greatly in detail, no single simple feature can be relied upon for identification. For example, specimens with purplish markings are rare in* A. compressus *and common in* P. conjugatum, *whereas the converse is true of leaf crinkling, but exceptions occur.*

Paspalum conjugatum

D. Tufts on extensively creeping stolons; roots yellow to brown; nodes and leaf bases often purplish; nodes have silky hairs 0.1 to 0.3 inch long, but sometimes hairless; inflorescence two divergent spikes.

E. Junction of leaf sheath and blade, use lens to find characteristic tuft of hairs at the apex of the ligule, adjacent portion often tinged purple; leaf blade usually smooth and tapering gradually to tip.

F. Spikelets oval, almost round, set alternately on either side of spike; those on one side overlap each other.

Non-flowering Paspalum conjugatum *can generally be distinguished from* Axonopus compressus *by darker roots, longer hairs on nodes and sheath edges, strong purple of nodes and of bases of leaf sheaths and blades, smoother leaf of more pronounced taper, more extensive creeping habit and the small tuft of hairs at the apex of the ligule.*

CONTROL OF SPECIFIC WEEDS. 2. WEEDS OTHER THAN GRASSES

Mikania Scandens

This can be killed readily by spraying with a weak solution of Fernoxone (sodium salt of 2,4-D). The rate of application recommended is 1 lb Fernoxone in 100 gallons per acre (see *Planters' Bulletin 38*, page 113).

Siam Weed (Eupatorium odoratum)

This weed, known locally under the name of Siam weed, can be eradicated by spraying with a solution of Fernoxone or Floroxone. The rate of application recommended is 5 lb Fernoxone or 4 pints Floroxone in 100 gallons per acre. Treatment with Fernoxone is cheaper but less certain and a second round of spraying may be necessary, depending on vigour of growth and on weather conditions immediately after spraying. The chances of success are better if Floroxone is used. The spray should be directed on to the foliage.

Straits Rhododendron (Melastoma polyanthum)

This can be successfully eradicated by spraying with a solution of Floroxone containing 5 pints of the liquid formulation in 100 gallons of water.

Maidenhair Creeper (Lygodium flexuosum)

This climbing fern, known locally under the name maidenhair creeper, is resistant to sodium arsenite and most of the other common weedkillers but it can be killed by spraying with Floroxone at the rate of 4 pints of the liquid formulation in 100 gallons of water per acre. Fernoxone is relatively ineffective.

Mimosa

The two most common varieties are *Mimosa pudica*, the small sensitive plant, and *Mimosa invisa* commonly known as giant mimosa. Both can be killed by spraying with Floroxone. A suitable solution is one that contains 4 pints of Floroxone in 100 gallons of water. A second round of spraying may be necessary for complete eradication of this weed.

Bracken (Gleichenia linearis)

For control of bracken a $1\frac{1}{2}\%$ solution of sodium arsenite is commonly used for spraying. Alternative weedkillers which may be considered are dalapon, aminotriazole and Floroxone. In small scale trials both dalapon and aminotriazole at the rate of 20 lb in 100 gallons of water per acre were effective in killing bracken; the effect of dalapon developed rather more rapidly than that of aminotriazole but in both cases the bracken was completely killed. New growth at twelve months after spraying was estimated to be not more than 5% in the plots sprayed with dalapon and about 1% after spraying with aminotriazole.

Good results were obtained also with a solution of Floroxone. The rate of application was 4 pints Floroxone in 100 gallons of water. Heavy growth of bracken was killed by one spraying treatment and little or no new growth has been observed up to nine months after spraying.

Wild Banana (Musa acuminata and M. malaccensis)

Wild banana plants can be controlled by slashing; this will not stimulate them to excessive sucker growth and they will become exhausted after a number of slashings and should die off. However, this is not a satisfactory method, except possibly when the banana plants grow in association with other indigenous growths which are normally controlled, but not eliminated, by slashing — as in jungle clearings.

It has been reported that the growing point can be killed effectively if, after slashing off the tops, a parang is thrust into the crown of the plant and twisted round. Another method which might be considered is to slash existing growth and spray the surface of the stumps with a 5% solution of Fernoxone. Young shoots can be killed readily by direct spraying (without previous slashing) with a 0.2% solution of Fernoxone.

The most effective method of eradicating wild banana is one which involves injecting a solution of Fernoxone into the stems. A suitable injector can be made by attaching a hollow needle about 3 or 4 inches long to an ordinary syringe. About 1 fluid ounce of the solution should be used per tree and should be injected deep into the stem at two or three points around the circumference near the base of the tree. A suitable solution for injection can be prepared by dissolving 2 ounces of Fernoxone in 1 gallon of water. This method is inexpensive and requires little labour. The stems rot and fall over about two or three weeks after injection. New shoots can readily be killed by spraying once, or perhaps twice at intervals of several weeks, when they are about 1 foot high. A solution of 0.2% concentration (8 ounces Fernoxone in 25 gallons of water) may be used for spraying the new shoots with an ordinary knapsack sprayer.

Bertam Palm

Bertam palm or Bertam attap (*Eugeissona tristis Griff.*), commonly found in jungle clearings, is difficult to eradicate in the normal way by slashing. New fronds continue to develop for a long time after burning of the jungle and several rounds of slashing at regular intervals are usually necessary for complete elimination of the palms. The alternative method of digging out the clumps after burning is costly. It has been found that the palm can be killed by spraying once with Lallicide (sodium trichloroacetate) or with dalapon at the rate of 8 and 4 ounces respectively in 2 pints of water per clump. Spraying should be done when new growth is about 3 feet high.

Rubber Seedlings

Self-sown rubber seedlings which frequently assume dominance in a cover of mixed indigenous growths in mature rubber areas can be selectively controlled by spraying with a solution containing half a pint of Floroxone in 100 gallons of water. Such a weak solution of Floroxone has little or no effect on most upright indigenous growths; it is thus possible to eliminate the rubber seedlings and still maintain an effective cover of mixed shrubs. Spraying at intervals of six months or longer gives effective control of the rubber seedlings.

CONTROL OF WEEDS IN PLANTING ROWS

While weedkillers are frequently required for eradication of specific weeds in localised patches, the main purpose for which weedkillers are currently used on most rubber estates is for routine maintenance of cleared strips along planting rows, i.e. strip spraying. Sodium arsenite, because it is cheap, and because it is a good general weedkiller, has been used extensively for this purpose. Few of the weed species found along planting rows, other than sedges, are resistant to this herbicide. Bearing in mind that the time may come when the use of sodium arsenite for routine control of weeds on estates may be banned because it is so highly toxic to humans and animals, it is necessary to consider what alternative non-toxic weedkillers could be used.

Experimental work is in progress involving small scale trials with a variety of new chemicals. Preliminary results are encouraging and there is little doubt that a suitable alternative to sodium arsenite, better than the ones now available, will be found in the near future. In the meantime it may be of interest to suggest possible alternatives which could be used immediately if necessary. Tentative proposals are:

(i) Sodium chlorate — 25 lb in 100 gallons of water. A $2\frac{1}{2}\%$ solution of sodium chlorate can be recommended for routine maintainance of cleared strips along planting rows. It is just as effective as a $1\frac{1}{2}\%$ solution of sodium arsenite for control of grasses and of most of the other small herbaceous weeds likely to be found where there has been a reasonably good standard of maintenance from the outset. The same number of spraying rounds would be required in a given period to give comparable results. The cost per lb of the two weedkillers is approximately the same but because 25 lb of sodium chlorate are needed to give an effect comparable with 15 lb of sodium arsenite the overall cost of strip spraying would be 67% higher with the former. It appears that sodium chlorate is less effective than sodium arsenite on wet land and it is appreciably less effective for control of heavy scrub growth, bracken, straits rhododendron, lalang and the coarser grasses which may be found in neglected areas.

(ii) A mixed solution containing 8 lb dalapon and 2 lb Fernoxone in 100 gallons of water is worth a trial on a limited scale. This will give good control of weeds in areas where grasses are dominant. Dalapon

OUTLINE OF THE PROPERTIES OF WEEDKILLERS USED ON RUBBER PLANTATIONS

Trade names given in parenthesis. Toxicity at recommended rates: H = high L = Low N = Nil

Weedkiller	*Effective against*	*Ineffective * against*	*Toxicity to rubber trees*	*Toxicity to men and animals*	*Recommended for*
1. Sodium arsenite	Most weeds including lalang and bracken	Sedges, ferns and a few of the coarser grasses	H	H	Strip-spraying of planting rows — but its poisonous nature is a serious disadvantage
2. Sodium chlorate	Most weeds, but less effective than (1)	Sedges, ferns and several broad-leafed weeds	L	N	Areas where (1) is forbidden or discouraged
3. Oils (Diesel, Shell Lalang, Sovacide, etc)	Grasses including lalang	Mature broad-leafed weeds	N	N	Wiping sporadic growth of lalang after applications of (1) or (5)
4. Sodium trichloracetate or 'T.C.A.' (Lallicide)	Grasses and seedling broad-leafed weeds	Mature broad-leafed weeds	L	N (but a skin irritant)	Control of grasses—as a possible alternative to (1) (2) and (5). Not highly recommended
5. Dalapon (Dowpon, Basfapon)	Grasses, including lalang. Sedges. Bracken	*P. conjugatum*	L	N	Grasses, including lalang, except where *P. conjugatum* is abundant. Sedges
	Not fully tested				
6. Aminotriazole (A.T.A., Amizol)	Grasses, including *P. conjugatum*. Sedges	less effective than (5) on grasses in general	N	N	Possibly *P. conjugatum* and sedges
7. 2,4-D formulations (Fernoxone etc)	Non-woody, broad-leafed plants	Grasses. Not very effective against woody plants	H (young rubber trees)	N	*Mikania scandens*, Siam weed, wild banana, water hyacinth
8. 2,4,5-T formulations (Trifen)	Woody and non-woody plants Trees	Grasses	H	N	This is an arboricide not usually recommended for weed-killing
9. Mixture of 2,4-D and 2,4,5-T esters (Floroxone)	Woody and non-woody plants	Grasses	H (rubber seedlings and trees)	N	Woody plants resistant to (7). Straits rhododendron, bracken, mimosa, maidenhair creeper, self-sown rubber seedlings

* When used at normally recommended rates.

should be replaced by aminotriazole for spraying areas where *Paspalum conjugatum* is the dominant grass species.

(iii) A solution containing 5 lb dalapon and 5 lb aminotriazole has given good results in small scale trials and is worth considering as an alternative to sodium arsenite for strip spraying in areas where there is a mixed population of grasses including *Paspalum conjugatum*. This mixture is possibly more suitable for use in areas where the rubber trees are 2 years old or more, and where they provide partial shade, than in more open areas where grasses are usually more vigorous. The effect develops slowly but persists much longer than that of sodium arsenite or sodium chlorate.

The cost of the mixtures mentioned above is higher than that of equivalent amounts of sodium arsenite and sodium chlorate but the overall cost of maintaining cleared strips along planting rows need not be proportionately higher. Fewer rounds of spraying will be required and it is expected that in most areas the rate of application of dalapon and/or aminotriazole can be reduced after the first or second round.

These are tentative suggestions pending further results from trials.

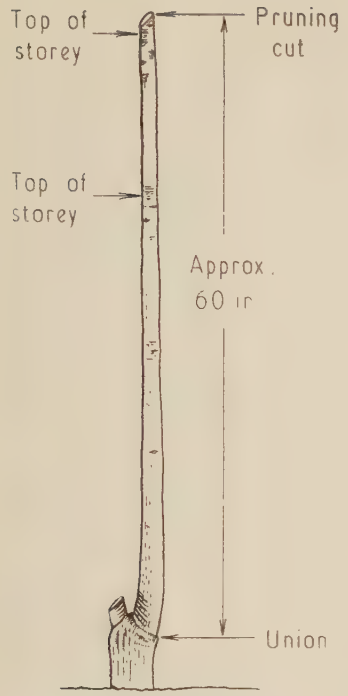
LIST OF PREVIOUS ARTICLES ON WEED CONTROL

Planters' Bulletin	*4*, 1953, p. 2	Weed Control on Rubber Estates.
„ „	*12*, 1954, p. 49	Weed Control in Young Rubber Areas.
„ „	*12*, 1954, p. 53	Mechanical Cultivation and Belukar Crushing.
„ „	*13*, 1954, p. 64	Covers and Weeding.
„ „	*23*, 1956, p. 27	A New Weed Killer for Control of Grasses.
„ „	*27*, 1956, p. 109	Sodium Chlorate, Weed Killer.
„ „	*29*, 1957, p. 27	Dowpon—Lalang and Grass Eradicant.
„ „	*31*, 1957, p. 74	Trial of the Holt Weed Breaker.
„ „	*38*, 1958, p. 113	Selective Control of Mikania and Rubber Seedlings by Spraying.

Transplanting Stumped Buddings

IN AN ARTICLE ENTITLED 'Stump Planting' in *Planters' Bulletin 6* of May 1953, information is given on the production and use of stumped buddings. Normally, this material is grown in the nursery for about 18 months from the time of cutting back stocks after budding. It is popular for supply planting and also for planting up small areas when residual material is available from old nurseries or from parts of the estate where budding double points in the field has been unusually successful.

Experience on estates suggests that such supplies of stumped buddings are increasingly valued by managers as planting material. Although it is still uncertain whether large scale production of such material is economically justified, planters may be interested in detailed instructions which will enable them to make the best use of large stumps which become available. The sketches and notes which follow deal with stumped buddings. The same principles may be usefully applied in transplanting large sized seedling stumps.

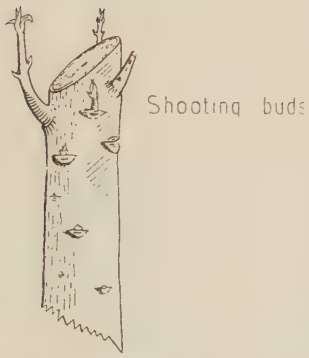


Stage I

1. Sloping pruning cut, to be smoothed with a sharp knife, and made just above * the top of the closely arranged dormant buds that mark the end of a growth 'storey'.

2. Bark from union to point of cut (approx. 60 in.) must be mature brown bark.

3. The union of stock and scion should be as complete as possible. (It would be best to 'snag' buddings to be used for replanting as stumped buddings as early as possible so that the union is closed over as completely as possible).

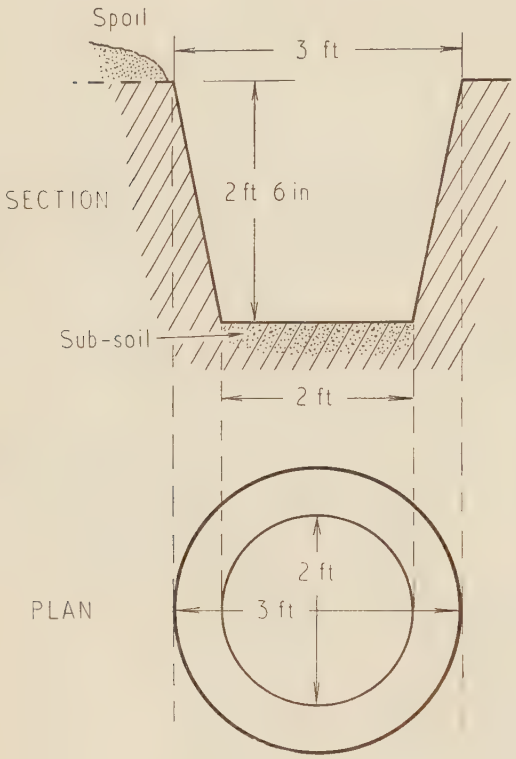


Stage II

After cutting back, the plant should remain undisturbed for 10 to 14 days or until the uppermost buds have actually shot. (It does not matter if some of the young shoots are damaged in transplanting because at this stage buds immediately below will have started growth and will quickly take the place of any 'overshot' buds that might be damaged).

Figure 1. Preliminary treatment of the plant.

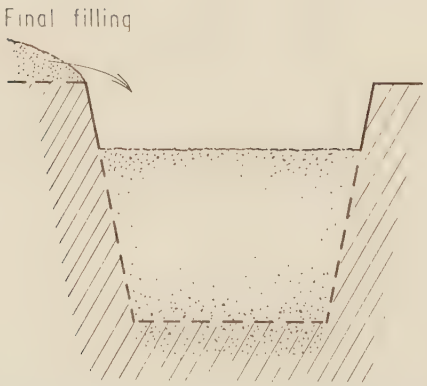
* The recommendation to prune above a whorl of closely arranged buds differs from our recommendation for pruning tall young plants to promote crown development. For good crown development three or four well spaced branches is the aim and the cut should be below a close whorl of buds. In transplanting stumped buddings the intention is to retain only a single shoot as high on the stump as possible and the pruning cut should be above a close whorl of buds so that the chance of securing a good, high shoot is increased.



1. Whilst the stumped buddings are reaching Stage II (Figure 1), transplanting holes should be prepared. These should be circular, 3 ft in diameter at the surface, tapering to about 2 ft at the base, and 2 ft 6 in. deep.

2. Sub-soil at bottom to be forked or otherwise broken up.

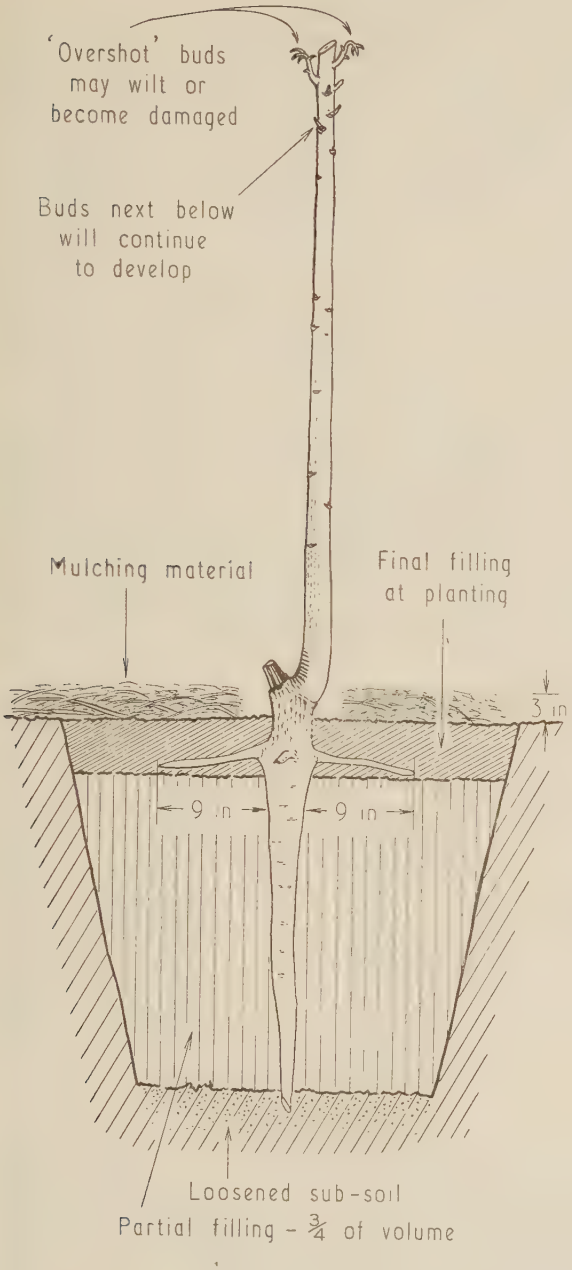
3. Spoil piled alongside for filling and mixing with fertiliser.



4. Holes to be three-quarters filled and soil allowed to settle for about a week (depending on rain) before transplanting.

5. Final soil for filling is thoroughly mixed with fertiliser and piled alongside.

Figure 2. Preparation of the planting hole.



1. Transplants must be dug out preserving about 12 to 15 in. of the main top whorl of laterals intact. Tap root should be at least 2 ft 6 in. long.
2. Clean-prune tap root at 2 ft 6 in., cutting away damaged tissue. Prune back main laterals to about 9 in.
3. Crowbar plant tap root in centre of hole, consolidating the soil so that laterals rest on the surface of the first filling soil.
4. Fill in with final top soil, consolidating firmly around collar and lateral roots.
5. Finally, spread the mulch over the surface to depth of about 3 in. (Lalang is probably best for this purpose). The mulch should not touch the plant.

Figure 3. Final preparation of plant and planting.

SP Rubbers in the First Half of 1959

THE DEMAND FOR SP RUBBERS continued to increase during the first six months of 1959 and the rate of production has kept ahead of increased orders. During this period commercial production of SP brown crepe began. Quarterly shipments in long tons of each kind of SP rubber for the last three quarters have been as follows:

Type of rubber	*4th Quarter 1958*	*1st Quarter 1959*	*2nd Quarter 1959*
SP RSS	314.5	336.8	387.1
SP ADS	31.0	–	7.0
SP Crepe	81.4	75.3	100.3
SP Brown Crepe	–	9.4	69.9
Total	426.9	421.5	564.3

Four companies are actively making SP rubbers on their estates in Malaya. We are confident that 1959 shipments will substantially exceed 2,000 tons per annum and thus almost double the 1958 output of 1,149 tons.

The destination of shipments during the first half of 1959 was as follows (figures in long tons):

Country	*1st Quarter 1959*	*2nd Quarter 1959*
Great Britain	101.3	153.1
New Zealand	45.0	100.1
Australia	43.0	84.0
U. S. A.	70.3	66.5
Japan	36.1	47.8
Germany	53.3	47.7
Italy	27.5	25.0
South Africa	16.0	15.0
France	19.0	13.8
Belgium	–	10.0
Sweden	10.0	–
Argentina	–	1
Algeria	–	0.3

Advertisements and technical information have appeared in technical journals in Great Britain, U.S.A., France, Germany, India and Japan.

Some important customers for Malayan rubber do not yet appear on this list and it is clear that certain countries are using more SP rubber relative to their total rubber requirements than others.

An account of SP rubber production in 1958 was published in *Planters' Bulletin 42*, page 70.

Approved Fungicides for Mouldy Rot Control

WE APPEND A LIST of the materials which have been tested by us and officially approved by the Department of Agriculture for the treatment of mouldy rot of the tapping panel. The last list to be published was included with an article on the disease in *Planters' Bulletin 25,* July 1956, on page 69. Certain revisions have become necessary. Four materials that have since been gazetted have been added. Three which were approved but are no longer available on the local market have been omitted. In one instance — Brunolinum Plantarium R.I. (Red Improved) — the recommended concentration range is changed; it is 5 – 10% instead of 10 – 15%.

Where a concentration range is given, the fungicide should normally be used at the lower strength, the higher concentration being employed only where there is difficulty in controlling the disease. Packing sizes are not yet known for the three most recently approved materials.

The tar acid fungicides on the list have been grouped together because they are also recommended in various issues of *Planters' Bulletin* for the treatment of root disease (*35,* page 38), pink disease (*37,* page 89), wounding (*71,* page 27) and fire damage (*41,* page 37). Two other materials — Fylomac 90 and Brunosil — give good control of pink disease when used at a concentration of 0.5%.

Name	*Local agents*	*Standard packings*	*Recommended concentration%*
Tar acid fungicides — emulsions or emulsifiable concentrates			
Agrisol	(1)	1, 5 gal	15 — 25
Agrisol White (Vulcan)	(1)	1, 5 gal	5 — 10
Agrisol Vulcan Red*	(1)	1, 5 gal	5 — 10
Black Cyllin	(2)	5 gal	5 — 10
Brunolinum Plantarium R.I. (Red Improved)*	(3)	1, 5 gal	5 — 10
Izal	(4)	1, 5, 10 gal	3 — 5
Killgerm	(5)	1, 5 gal	5 — 10
Kilsol Red*	(6)	1, 5 gal	5 — 10
Sanitas Okol	(7)	5 gal	30
Other materials			
Antimucin WBR	(8)		0.25 — 0.5
Brunosil	(3)		0.25
Cargilineum Mixture	(9)	40 lb	neat
Fylomac 90*	(10)	1, 10 lb	0.28
Seprisan*	(11)		0.25 — 0.5

* containing a dye to facilitate supervision in the field.

Local agents: (1) Sime, Darby (Malaya) Ltd. (2) Sandilands Buttery & Co. Ltd. (3) James Warren & Co. Ltd. (4) Guthrie & Co. Ltd. (5) McAlister & Co. Ltd. (6) Kyle, Palmer & Co. Ltd. (7) The Anglo-Thai Corporation Ltd. (8) Malayan Fertilisers Ltd. (9) Boustead & Co. Ltd. (10) Imperial Chemical Industries (Malaya) Ltd. (11) Rotterdam Trading Co. (Malaya) Ltd.

R. R. I. News

Mr S.N. Angove joined the staff of the Chemical Division of the Institute in August. He has been trained at the National College of Rubber Technology, London, of which he is a Fellow. He is also an Associate of the Institution of the Rubber Industry and of the Plastics Institute.

During the past year Mr Angove has had special training at the British Rubber Producers' Research Association, and also with firms using natural rubber latex. At the R.R.I. he will continue with work in latex testing and technology and will pay special attention to the problem of variation in the processing qualities of latex.

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Mr G.A. Gilbertson assumed duty on 18 May 1959 as Resident Engineer at the R.R.I. Experiment Station, after 11 years experience in Malaya with tin mining companies and with the Central Electricity Board. He holds an Engineer's Certificate and Part A of A.M.I. Mech. E.

Mr Gilbertson will be responsible for the provision of all services at the Experiment Station requiring a knowledge of engineering; they include water and electricity supply, sanitation, and the maintenance of machinery, vehicles, factory equipment, and buildings.

Correspondence

COVER CROP SEEDS

I feel that the article in *Planters' Bulletin 39*, 'Pretreatment of Leguminous Cover Crop Seeds' tended to be over-cautious in its approach to treatment of seeds with *concentrated sulphuric acid*. In fact the process is extremely simple and can be carried out using normal estate equipment. Possibly the best way of explaining this is to describe a method which has been found successful.

About 8 lb of *Pueraria phaseoloides* seed (or one gallon) are placed in a 3 gallon aluminium bucket and 4 pints of cheap commercial concentrated sulphuric acid are added. This is stirred for some twenty minutes with a strip of aluminium (a glass rod would do or even wood). As soon as the majority (say 80%) of the seeds become light in colour, having lost their darker skin, the action is stopped by pouring the contents of the bucket into a coagulating tank previously three-quarters filled with water (in this way the danger of adding water to acid is eliminated). After thorough agitation for a few minutes the water is run off from the tank using a piece of gauze to prevent loss of seeds. The tank is refilled and left overnight (about 12 hours). Then the seeds are washed in a strainer, placed in a muslin bag for partial drip drying, inoculated with Rhizobium and planted in the usual way.

There seems no reason why any estate should not be able to pretreat all its seed in this way. Except for the slightly greater care required in handling concentrated sulphuric acid, no extra supervision should be required.

A.C. Nicoresti

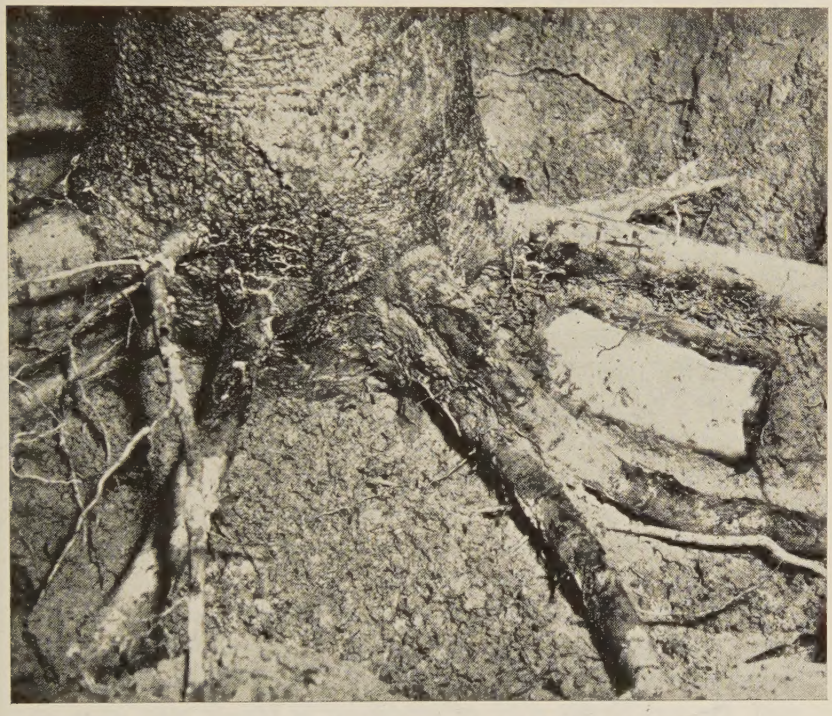
Sungkai, Perak

Seeds so treated are drought susceptible. However, the reduction in seed rate to about one-third of normal after such pre-

treatment means that a second attempt can still be made economically if the first fails owing to an unexpected period of drought.

We would advise dusting with ground rock phosphate (equal weight to seed) after pretreatment whether or not the seeds are inoculated.

Although, as indicated, the process can be made relatively simple using normal estate factory equipment, we consider that it is essential to emphasise caution in the use of concentrated sulphuric acid. Even if the actual risk of an accident can be reduced, the fact remains that an accident with concentrated sulphuric acid is liable, indeed likely, to be serious. Apart from the misfortune to an individual who might, for example, lose his sight, the position of a company which allowed such dangerous chemicals to be used without proper supervision would be unenviable.—Editor



WHITE ROOT DISEASE

It often happens that scientists are busily engaged in inducing the very diseases which they are trying to prevent! An example of this kind of work is illustrated above.

The photograph shows a six-year-old tree dying of white root disease—eight months after inoculation with a pure culture of Fomes lignosus *contained in the bottle seen at the right of the photograph. This method of inoculation, developed by our Pathological Division, meets a need for inocula of standard and reproducible infecting potential. It will assist investigations of rootstock resistance and of variations in the pathogenicity of different strains of the fungus. It will also allow precise evaluation of fungicidal treatments.*

IN MEMORIAM

HAROLD SEGAR BLACKLIN

July 24th, 1959

After serving in the Royal Navy during the European War of 1914-1919 Harold Segar Blacklin came to Malaya in 1920. He worked as a rubber planter in the Batang Padang district of Perak and was Manager of Bedrock Estate when he left planting to take up an administrative post.

In 1930 he joined the late Mr C. Ward-Jackson in Kuala Lumpur as Assistant Secretary of the United Planting Association of Malaya before being appointed Secretary of the Rubber Research Institute in March, 1932.

In his work for the Rubber Research Institute he served as Secretary to the Board and was responsible for much of the day-to-day administrative work of the Institute. He came to us in the dark days of the early nineteen thirties and worked with the Directors and Staff and many Board members to build up the work of the Institute during the years 1934 to 1942.

When the Japanese invasion reached Kuala Lumpur in January 1942, 'H.S.B.' remained at his post and despite dangers and difficulties did much to help the staff of the Institute and to preserve its property and records. During the latter part of the War in Malaya he was interned in Singapore but he was one of the first of the senior staff to return to the Institute in December 1945 to help in the work of reconstruction.

Malaya had become the country of his adoption and for twenty-seven years he made it his life's work to interest himself in the progress of the Rubber Research Institute and the welfare of its staff. He was on the point of retirement in March 1959 when on urgent medical advice he went to England for medical attention. He died at the Mount Vernon Hospital, Middlesex on July 24th, 1959.

The Institute has lost a devoted servant, and every member of the staff has lost a beloved friend and adviser.

The deepest sympathy of members of the staff and the Board goes to his sorrowing wife and family.

MALADIES OF HEVEA IN MALAYA

by

ROGER N. HILTON

with 41 coloured illustrations by

HOH CHOO CHUAN

This publication of the Rubber Research Institute is priced at $30 (Malayan) but is available at $20 in the Federation of Malaya, Singapore, Brunei, North Borneo, Sarawak and Nigeria.

Prepared primarily as a recognition manual for planters, it covers the diseases, injuries and disorders of the rubber plant. *Each description of a malady is accompanied by a full-page coloured illustration.*

CONTENTS

Maladies of Hevea—symptoms, cause, other plants affected, spread, prevention, treatment. *The Whole Plant*—drought and wilting, flooding and waterlogging. *Root*—white root disease, red root disease, brown root disease, stinking root rot, poria root rot, ustulina root rot. *Stem and Branches*—dieback, stem ustulina, stem scorch, gloeosporium dieback, colletotrichum dieback, mistletoes, fire damage, herbicide injury, lightning strike, thread blight, pink disease, horsehair blight, bark bursts and burrs. *Tapping Panel*—panel fissures and burrs, brown bast, white fan blight, black stripe, mouldy rot. *Leaf of the Young Plant*—bird's eye spot, anthracnose, powdery mildew, gloeosporium, colletotrichum, sunscorch, poisoning. *Leaf*—chlorosis and veining, genetic yellows and mottling, oil spot, rim blight, malformation. *Leaf of the Mature Plant*—secondary leaf fall (oidium), secondary leaf fall (gloeosporium), algal spot. *Index.*

OUR COVER SHOWS CONTROL OF WEEDS IN THE PLANTING ROW : ROW SPRAYED WITH 2½% SOLUTION OF SODIUM CHLORATE.

The Standard Engravers & Art Printers, 63 Campbell Road, Kuala Lumpur, Selangor